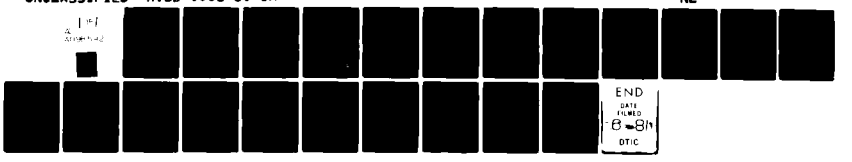
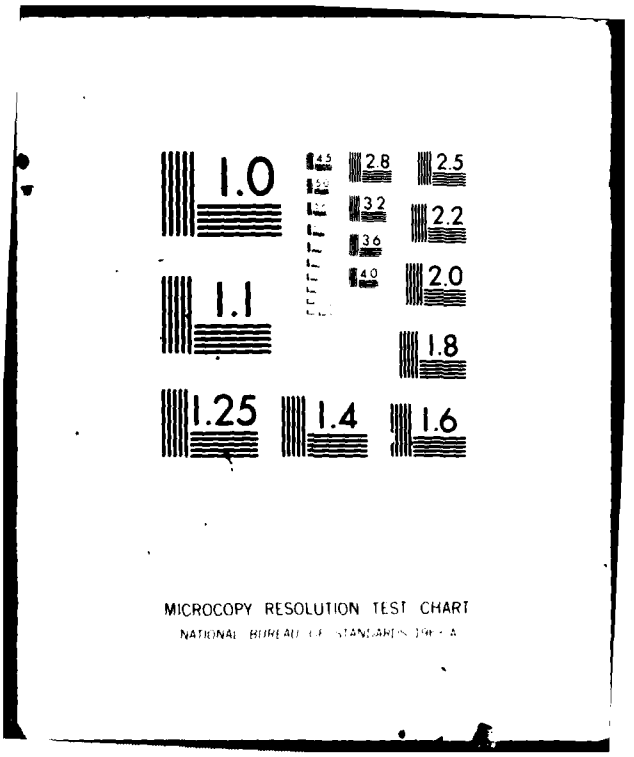
AD-A098 592 AVCO SYSTEMS DIV WILMINGTON MA F/G 16/3
MINUTEMAN III/MARK 12A REENTRY VEHICLE CARBON-CARBON NOSETIP PR--ETC(U)
FEB 80 F04704-78-C-0036
UNCLASSIFIED AVSD-0058-80-CR NL

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1.1
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4.0
4.5
MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS 1963-A

201 LOWELL STREET, WILMINGTON, MASSACHUSETTS 01887 TEL: (617) 657-2333

AD A098592

LEVEL II

21 February 1980
S300-DJM-80-37

Department of the Air Force
Ballistic Missile Office
Norton Air Force Base
San Bernardino, CA 92409

Attention: MNNR/Captain G. Parnell

Gentlemen:

Subject: Transmittal of Aveo Document AVSD-0053-80-CR, General Test Report, MMIII/MK12A Reentry Vehicle, Carbon/Carbon Nosetip Production, dated 21 February 1980. Contract F04704-78-C-0036

Reference:
A. Subject Contract, Attachment 1, Task 4.2.1.1
B. CDRL Sequence Number 0014A2
C. CDRL Sequence Number 0030A2
D. Aveo Document AVSD-0302-79-CR, General Test Report, dated 13 December 1979
E. BMO Letter dated 24 January 1980, Subject: Aveo Carbon-Carbon Nosetip Test Report

The subject document is transmitted herewith in accordance with Reference A and in compliance with Reference B and as formatted in Reference C. This document is a resubmittal of Reference D which was considered incomplete per Reference E.

Aveo requests that BMO review and approve this document within thirty (30) days.

Very truly yours,

D. J. McQueen
Program Manager

cc: (w/o enclosure) Aveo/SD, Attention: Mr. D. J. Sullivan, Contracts Administrator
BMO/MNNCA-1, Attention: Mr. C. Howard Kirk

Enclosure: Subject Document

81 5 04 179

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San Bernardino, CA 92409
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San Antonio Air Logistics Center
Kelly Air Force Base, TX 78241
Attention: MMETC (1)

Battelle Columbus Laboratories
Metals and Ceramics Information Center
Attention: D. L. Moybuth
505 King Avenue
Columbus, Ohio 43201 (1)

(9) GENERAL TEST REPORT. 1 Sep-31 Nov 79.

PRODUCTION LOT SAMPLING

(14) AVSD-0058-80-CR

(6) MINUTEMAN III/MARK 12A REENTRY VEHICLE
CARBON-CARBON NOSETIP PRODUCTION.

CDRL SEQUENCE NUMBER 081A2

(REPORT PERIOD 1 SEPTEMBER 1979 - 31 NOVEMBER 1979)

(11) 21 FEB 1980

(12) 47

Prepared By (15) F04704-78-C-0036

AVCO SYSTEMS DIVISION
201 Lowell Street
Wilmington, Massachusetts 01887

Prepared For

DEPARTMENT OF THE AIR FORCE
BALLISTIC MISSILE OFFICE
Norton Air Force Base
San Bernardino, California 92409

47477

FOREWORD

As required one (1) densified billet out of each ~~thirty-six~~ (36) processed is randomly selected and subjected to the Production Lot Sampling Tests specified in paragraph 5.2.3 of the Equipment Test Plan, AVSD-0325-78-CR, dated 14 March 1979. Several test results were encountered which did not fall within the values specified in the individual Quality Assurance Test Procedures (~~QA~~TP's). A summary of all test results from PLS-2, -3, and -4 and rationale concerning the variances will be presented. All data has been compiled on previously presented Figures 7, 8, and 9 from the Equipment Test Plan, and included herein as the General Test Report, Production Lot Sampling, in accordance with CDRL [illegible].

1.0 SUMMARY OF TEST RESULTS

The summary of test results are presented for PLS-2 on Figures 1 through 4, for PLS-3 on Figures 5 through 8, and for PLS-4 on Figures 9 through 12.

Any test results not conforming to the requirements of Annex 1A to Attachment 1 of Contract F04704-78-C-0036 have been denoted by an asterisk.

The following is a summary of the test results which did not conform to the specification values:

Test	Effectivity
Thermal Conductivity	PLS-2, PLS-3, PLS-4
Compressive Yield Strength	Specimen CX-2 from PLS-2
45° Xy tension . 1% offset Yield	Specimen TXY-1 from PLS-4

2.0 RATIONALE FOR NON-CONFORMING RESULTS

2.1 Thermal Conductivity - The underlined test results in Table I do not conform to the specification requirements.

TABLE I

Thermal Conductivity	Requirement BTU in/hr ft^2 °F	PLS 2	PLS 3	PLS 4
z @ 500°F	640 - 760	824	638	630
z @ 1500°F	410 - 480	460	490	470
x @ 500°F	810 - 965	968	915	910
x @ 1500°F	495 - 590	630	610	600

2.1.2 Rationale - As has been discussed at recent TI/TD meetings, the specification requirements for thermal conductivity were established on a limited test data base (3 billets). Recent discussions between Avco, BMO, TRW and SoRI has resulted in agreement to reestablish the requirements when a sufficient data base has been reached (possibly when ten (10) PLS tests have been performed). In the meantime all conductivity tests will be performed at SoRI with corresponding tests being performed at Avco to establish a correllation of attainable values, equipment variables and test procedures.

2.2 Compressive Yield Strength - The compressive yield strength for PLS #2 test specimen CY-2 was 14,900 psi vs. the minimum requirement of 15,200 psi.

2.2.1 Rationale - The original test data for establishing the minimum requirement was based upon 6 tests. These tests yielded an average value of 17,400 psi and a standard deviation of 0.94. Further testing of the FWPF has revealed that after 18 tests the average value is 17,000 psi and the standard deviation is 1.21. Based upon these test data the test result is within the expected population. It appears that further testing of the FWPF is required to establish a more meaningful data base, which can then be used to possibly [illegible] specification limit.

2.3 45^{o} XY Tension - The 45^{o} Xy tensile bar TXY-1 from PLS-4 did not meet the minimum specification requirement.

2.3.1 Rationale - The PLS-4 TXY-1 test specimen was preloaded prior to testing. This occurred during mounting which proceeds as follows. The specimen is first mounted in the upper grip. Next the lower grip is engaged by a collet action which closes the jaws around the test specimen. This action is created by twisting a handle below the specimen. As the lower jaw is closed, the lower cross-head should be raised to compensate for the upward travel in the lower jaw. The lower cross-head was not raised at this time to compensate for the travel in the lower jaw, thereby preloading the specimen. This preload was not recorded because the pen was not engaged and prior to testing the recorder pen was reset to zero, which precluded the possibility of making any determination as to the magnitude of the preload. If this preload could have been accounted for in the measured load, then in all likelihood the specimen would have passed. The minimum preload to be accounted for in this case would be 31 lbs. which when added to the 463 lbs. obtained, would have yielded a stress of 3500 psi. Based upon the preceding discussion this test should be considered a No Test. The corrective action for this anomally was to revise QATP 30551 to preclude preloading of the specimen.

PLS SUMMARY DATA SHEET

MECHANICAL PROPERTIES - TYPE II CARBON/CARBON BILLETS

BILLET S/N H900410 (P1412A) PLS-2

PROPERTY	TEST SPECIMEN	TEST VALUE	REQUIREMENT (MIN.)
ULTIMATE TENSILE STRENGTH			
X	TX-1	[illegible]	[illegible]
	TX-2	29900	
	TX-3	27300	
	TX-4	26600	
Z	TZ-1	26100	16500 PSI
	TZ-2	26800	
	TZ-3	25600	
TENSILE MODULUS			
X	TX-1	14.1	8.5×10^6 PSI
	TX-2	13.3	
	TX-3	12.9	
	TX-4	13.0	
Z	TZ-1	12.0	9.4×10^6 PSI
	TZ-2	11.9	
	TZ-3	12.1	
COMPRESSIVE YIELD STRENGTH			
X	CX-1	15200	15200 PSI
	CX-2	14900 *	
	CX-3	15900	
Z	CZ-1	12600	11000 PSI
	CZ-2	11500	
	CZ-3	12900	

FIGURE 1 (Cont.)

PLS SUMMARY DATA SHEET

MECHANICAL PROPERTIES - [illegible] COMPRESSION BILLETS

BILLET S/N E900410 (PI413A) PLS-2

PROPERTY	TEST SPECIMEN	TEST VALUE	REQUIREMENT (MIN.)
COMPRESSIVE MODULUS			
X	CX-1	13.2	11.2×10^6 PSI
	CX-2	12.5	
	CX-3	13.2	
Z	CZ-1	10.6	8.4×10^6 PSI
	CZ-2	9.3	
	CZ-3	9.9	
45° XY TENSION, .1% OFFSET YIELD			
	TXY-1	4690	3500 PSI
	TXY-2	4640	
TORSIONAL SHEAR, .2% OFFSET YIELD			
	TS-1	1470	1100 PSI
	TS-2	1470	

PLS SUMMARY DATA SHEET
TYPE II CARBON/CARBON BILLET

THERMAL PROPERTIES

BILLET S/N: [illegible]

[illegible]	[illegible]	[illegible]	[illegible]
THERMAL EXPANSION			Δ L/L x 10³ IN/IN @ 4000°F
X @ 4000°F	TEX-1	3.41	3.2 TO 4.1
	TEX-2	3.35	
Z @ 4000°F	TEZ-1	3.29	3.1 TO 4.1
	TEZ-2	3.43	

THERMAL CONDUCTIVITY			BTU IN/HR FT² °F
Z @ 500°F	TCZ-1	824 *	640 - 760
Z @ 1500°F	TCZ-1	460	410 - 480
X @ 500°F	TCX-1	968 *	810 - 965
X @ 1500°F	TCX-1	630 *	495 - 590

TYPE II CARBON/CARBON BILLET

BILLET S/N H900410 (PLS 2) DATE 12/07/79

PREFORM S/N A950011 (P1412A)

DENSIFICATION LOT(S) 3

BILLET SIZE 8.127 x 3.241 x 3.242

BILLET WEIGHT 2790.2 grams

BULK DENSITY 1.994 gm/cc

RADIOMETRIC DENSITY

EDGE TO CORE RATIO 0.993
END TO END GRADIENT 0.0013
SIDE TO SIDE GRADIENT 0.021

OPEN POROSITY 4.17%

FRACTURES (X) None
& INCLUSIONS (Y) None

VISUAL INSPECTION Accept

PREFORM DATA SUMMARY

MISSING/DISPLACED YARN
BUNDLES (Z) None

FIBER ORIENTATION W/In 2°

Z AXIS BENDING None

Z ELEMENT SPACING W/In ± .005

XY LAYER SPACING W/In ± .002

BULK DENSITY 1.096 gms/cc

DENSITY GRADIENT (MAX) 0.154 gm/cc

FIGURE 4

PLS SUMMARY DATA SHEET (FOR PLS BILLETS ONLY)
TYPE II CARBON/CARBON BILLET

BILLET S/N H900410 (PLS-2)

PREFORM S/N A950011 (P1412A)

FABRIC ACCEPTANCE DATA

WEAVER Textile Products

LOT NUMBER 268

DEFECTS Accept

CONTAMINATION Accept

WEAVE CONSTRUCTION 8 Harness Satin

VOLATILE CONTENT 4.45

YARN COUNT 30 Warp 30 Fill

WEIGHT 4.92 oz./sq. yd.

THICKNESS 0.13

BREAKING STRENGTH 302.4 Warp 292 Fill

YARN ACCEPTANCE DATA (FOR ABOVE CLOTH)

TYPE	LOT NO.	TENSILE STRENGTH (PSI)	MODULUS X 10^6 PSI	Length/unit wt. (km/kg)	DENSITY gm/cc
HM-1000 PAN	83-4	[illegible] x 10^3	56.9	15	1.855
	XXXX				
HM-3000 PAN	75-4	[illegible] x 10^3	[illegible].1	[illegible]	[illegible]
	YYY				

Exhibit [illegible]

PLT SUMMARY DATA SHEET

MECHANICAL PROPERTIES - TYPE I SPECIMENS FOR BILLETS

BILLET S/N K900106 (P/N 288A) FLS-3

PROPERTY	TEST SPECIMEN	TEST VALUE	REQUIREMENT (MIN.)
ULTIMATE TENSILE STRENGTH			
X	TX-1	[illegible]	[illegible]
	TX-2	31800	
	TX-3	28400	
	TX-4	32500	
Z	TZ-1	19600	16500 PSI
	TZ-2	19700	
	TZ-3	22500	
TENSILE MODULUS			
X	TX-1	14.0	8.5 x 10^6 PSI
	TX-2	14.0	
	TX-3	13.5	
	TX-4	16.8	
Z	TZ-1	9.7	9.4 x 10^6 PSI
	TZ-2	9.4	
	TZ-3	10.9	
COMPRESSIVE YIELD STRENGTH			
X	CX-1	16700	15200 PSI
	CX-2	16900	
	CX-3	17200	
Z	CZ-1	11100	11000 PSI
	CZ-2	16600*	
	CZ-3	16000*	

* Tested to Amendment 1 of QATP 30552

PLS SUMMARY DATA SHEET
MECHANICAL PROPERTIES - TYPE 11 CARBON/CARBON BILLETS

BILLET S/N P900106 (P1425A) PLS-3

PROPERTY	TEST SPECIMEN	TEST VALUE	REQUIREMENT (MIN.)
COMPRESSIVE MODULUS			
X	CX-1	15.5	11.2 x 10^6 PSI
	CX-2	14.9	
	CX-3	14.5	
Z	CZ-1	10.6	8.4 x 10^6 PSI
	CZ-2	10.4	
	CZ-3	11.1	
45° XY TENSION, .1% OFFSET YIELD			
	TXY-1	3810	3500 PSI
	TXY-2	3770	
TORSIONAL SHEAR, .2% OFFSET YIELD			
	TS-1	1140	1100 PSI
	TS-2	1170	

* Tested to Amendment I of QATP 30553

PLS SUMMARY DATA SHEET
TYPE II CARBON/CARBON BILLET

THERMAL PROPERTIES

BILLET S/N K900166 (P142384) PLS-3

THERMAL EXPANSION			Δ L/L x 10^{-2} IN/IN @ 4000°F
X @ 4000°F	TEX-1	3.40	3.2 TO 4.1
	TEX-2	3.26	
Z @ 4000°F	TEZ-1	3.49	3.1 TO 4.1
	TEZ-2	3.42	

THERMAL CONDUCTIVITY			BTU IN/HR FT^2 °F
Z @ 500°F	TCZ-1	638 *	640 - 760
Z @ 1500°F	TCZ-1	490 *	410 - 480
X @ 500°F	TCX-1	915	810 - 965
X @ 1500°F	TCX-1	610 *	495 - 590

FIGURE 7

TYPE II CARBON/CARBON BILLET

BILLET S/N [illegible] DATE [illegible]

PREFORM S/N C90b029 (P1428A)

DENSIFICATION LOT(S) 4

BILLET SIZE 3.129 x 3.228 x 3.239

BILLET WEIGHT 2760.7 gms

BULK [illegible]

RADIOMETRIC DENSITY

EDGE TO CORE RATIO 1.0010

END TO END GRADIENT [illegible]

SIDE TO SIDE GRADIENT 0.010

OPEN POROSITY 4.27%

FRACTURES (X) None
& INCLUSIONS (Y) None

VISUAL INSPECTION Accept

PREFORM DATA SUMMARY

MISSING/DISPLACED YARN
BUNDLES (Z) None

FIBER ORIENTATION W/In 2°

Z AXIS BENDING None

Z ELEMENT SPACING W/In + .005

XY LAYER SPACING W/In + .002

BULK DENSITY 1.091 gms/cc

DENSITY GRADIENT (MAX) 0.069 gm/cc

FIGURE 8

PLS SUMMARY DATA SHEET (FOR PLS BILLETS ONLY)
TYPE II CARBON/CARBON BILLET

BILLET S/N K900106 (PLS-3)

PREFORM S/N C900629 (P1426A)

FABRIC ACCEPTANCE DATA

WEAVER Textile Products

LOT NUMBER 230

DEFECTS Accept.

CONTAMINATION Accept

WEAVE CONSTRUCTION 8 Harness Satin

VOLATILE CONTENT 1.25

YARN COUNT 29.0 Warp 29.0 Fill

WEIGHT 5.12 oz./sq. yd.

THICKNESS .012/.013

BREAKING STRENGTH 261.7 WARP 254.6 FILL

YARN ACCEPTANCE DATA (FOR ABOVE CLOTH)

TYPE	LOT NO.	TENSILE STRENGTH (PSI)	MODULUS X 10^9 PSI	Length/Unit Wt (m/)	DENSITY gm/cc
HM-1000 PAN	118-1	423 x 10^3	54.7	1[illegible]	1.82
	XXXX				
HM-3000 PAN	97.3	387 x 10^3	54.7	[illegible]	1.82
	YYY				

PLS SUMMARY DATA SHEET
MECHANICAL PROPERTIES - TYPE II CARBON/CARBON BILLETS

BILLET S/N N2001S4 (P1435A) PLS-4

PROPERTY	TEST SPECIMEN	TEST VALUE	REQUIREMENT (MIN.)
ULTIMATE TENSILE STRENGTH			
X	TX-1	31500	18200 PSI
	TX-2	27950	
	TX-3	28900	
	TX-4	31600	
Z	TZ-1	25500	16500 PSI
	TZ-2	26800	
	TZ-3	29100	
TENSILE MODULUS			
X	TX-1	12.6	8.5×10^6 PSI
	TX-2	14.9	
	TX-3	12.7	
	TX-4	15.4	
Z	TZ-1	12.6	9.4×10^6 PSI
	TZ-2	13.0	
	TZ-3	12.6	
COMPRESSIVE YIELD STRENGTH*			
X	CX-1	16200	15200 PSI
	CX-2	18300	
	CX-3	17700	
Z	CZ-1	16500	11000 PSI
	CZ-2	17000	
	CZ-3	16300	

* Tested to Amendment 1 of QATP 30552

PLS SUMMARY DATA SHEET

[illegible] - TYPE II CARBON/CARBON BILLETS

BILLET S/N: 1990154 (P1435A) PLS-4

PROPERTY	TEST SPECIMEN	TEST VALUE	REQUIREMENT (MIN.)
COMPRESSIVE MODULUS			
X	CX-1	13.1	11.2×10^6 PSI
	CX-2	13.2	
	CX-3	12.4	
Z	CZ-1	10.9	8.4×10^6 PSI
	CZ-2	11.5	
	CZ-3	11.6	
45° XY TENSION, .1% OFFSET YIELD			
	TXY-1	No Test *	3500 PSI
	TXY-2	3660	
TORSIONAL SHEAR, .2% OFFSET YIELD *			
	TS-1	1250	1100 PSI
	TS-2	1230	

* Tested to Amendment I of QATP 30553

PLS SUMMARY DATA SHEET
TYPE II CARBON/CARBON BILLET

THERMAL PROPERTIES

BILLET S/N M900154 (P1435A) PLS-4

THERMAL EXPANSION			$\Delta L/L \times 10^2$ IN/IN @ 4000°F
X @ 4000°F	TEX-1	3.65	3.2 TO 4.1
	TEX-2	3.50	
Z @ 4000°F	TEZ-1	3.60	3.1 TO 4.1
	TEZ-2	3.52	

THERMAL CONDUCTIVITY			BTU IN/HR FT^2 °F
Z @ 500°F	TCZ-1	630 *	640 - 760
Z @ 1500°F	TCZ-1	470	410 - 480
X @ 500°F	TCX-1	910	810 - 965
X @ 1500°F	TCX-1	600 *	495 - 590

FIGURE 11

TYPE II CARBON/CARBON BILLET

BILLET S/N 3900159 (BL-4) DATE 1/07/79

PREFORM S/N: C900735 (1435A)

Ddensification LOT(S) 5

BILLET SIZE 8.065 x 3.240 x 3.239

BILLET WEIGHT 2729.6

Bulk [illegible]

RADIOMETRIC DENSITY

EDGE TO CORE RATIO 1.007

END TO END GRADIENT 0.020

SIDE TO SIDE GRADIENT 0.000

OPEN POROSITY 4.42%

FRACTURES (X) None
& INCLUSIONS (Y) None

VISUAL INSPECTION Accept

PREFORM DATA SUMMARY

MISSING/DISPLACED YARN
BUNDLES (Z) None

FIBER ORIENTATION W/In 2°

Z AXIS BENDING None

Z ELEMENT SPACING W/In + .005

XY LAYER SPACING W/In + .002

BULK DENSITY 1.091 gms/cc

DENSITY GRADIENT (MAX) 0.070 gm/cc

FIGURE 12

PLS SUMMARY DATA SHEET (FOR PLS BILLETS ONLY)
TYPE II C[illegible]/CARBON BILLET

BILLET S/N M800154 (PLS-4)

PREFORM S/N C900735 (P1435

FABRIC ACCEPTANCE DATA

WEAVER Textile Products

LOT NUMBER 232

DEFECTS Accept

CONTAMINATION Accept

WEAVE CONSTRUCTION 8 Harness Satin

VOLATILE CONTENT 1.0

YARN COUNT 29 WARP 29 FILL

WEIGHT 5.19 oz/sq. yd.

THICKNESS .0135 to .0138

BREAKING STRENGTH 258 WARP 271 FILL

YARN ACCEPTANCE DATA (FOR ABOVE CLOTH)

TYPE	LOT NO.	TENSILE STRENGTH (PSI)	MODULUS X 10^6 PSI	Length (m)	Unit Wt.	DENSITY GM/CC
HM-1000 PAN	118-2	405 x 10^3	57.0	[illegible]	9	[illegible]
	XXXX					
HM-3000 PAN	97-3	387 x 10^3	54.7	[illegible]	8	[illegible]
	YYY					


LMED
8